

Lake, and for Lake Superior from Duluth to Houghton. Later in the morning northeast warnings were extended over the remainder of Lake Superior and were also issued for Lake Huron and northeastern Lake Michigan, and for Chicago. Special observations at 2 p. m. indicated that the disturbance was moving more to the northward than at first expected; therefore, at 3:30 p. m., the northeast warnings on Lake Huron were changed to southeast, and at the same time southeast warnings were issued for Lake Erie; later, at 9:30 p. m., southeast warnings were extended over Lake Ontario. Verifying velocities from the directions indicated were confined to northern Lake Huron, but as the storm passed to the eastward practically all stations experienced verifying velocities from a westerly direction. Whitefish Point, Mich., reported a maximum velocity of 68 miles an hour, and Middle Island, one of 64 miles an hour. At 9 a. m. of the 5th the warnings were changed to northwest from Houghton east on Lake Superior, and also on northern Michigan, eastern Erie, Huron, and Ontario. Action had been taken one hour previously, however, by the officials at Alpena, Mich., and Buffalo, N. Y., to effect this change. Owing to the persistence of winds of gale force at Oswego, N. Y., on the morning of the 6th the warnings were continued over extreme eastern Ontario until 4 p. m. of that date.

Southeast warnings were issued on the night of the 6th for the west shore of Lake Michigan from Chicago to Sheboygan in anticipation of the development of a disturbance of wide extent then over the West, but the warning was lowered on the following morning when it had become apparent that winds of storm strength probably would not occur. However, as this disturbance reached the upper Lakes it increased in energy, and on the morning of the 8th northwest warnings were ordered for Lake Superior from Houghton eastward, and for Lake Huron and the eastern shore of Lake Michigan; while southwest warnings were displayed on Lake Ontario and on Lake Erie from Erie eastward. In most cases these warnings were verified. By 8 p. m. of the 8th the storm had spent its force on the Lakes and therefore all warnings were lowered.

On the evening of the 10th a disturbance of considerable geographic extent occupied the northern Rocky Mountain and Northern Plains States, while a high-pressure area of great magnitude covered the East. At that time northeast warnings were ordered for the Duluth and Ashland sections of Lake Superior, and southeast warnings for the remainder of that lake. On the following morning the disturbance extended from the upper Mississippi Valley southwestward to Colorado. An area of high pressure and low temperature appeared to the northwestward. Accordingly, the warnings on Lake Superior were changed to northwest and at the same time southwest warnings were issued for Lakes Michigan, Huron, Erie, and Ontario. As the result of special observations in the afternoon the warnings were changed to northwest on Lakes Michigan and Huron, and on Lake Superior from Marquette eastward, and on the following morning they were changed to northwest over eastern Lake Erie. All these warnings were fully verified, the storm being severe over certain portions of the lakes. At Buffalo, N. Y., a maximum velocity of 72 miles an hour was experienced; on Lake Superior the tug *Reliance* grounded on the rocky shores of Lizard Island and was reported to have been wrecked.

The final storm warnings for the season were issued on the night of the 19th and the morning of the 20th in

connection with a disturbance of moderate strength that was centered over the Red River at 8 p. m. of the 19th. Northwest warnings were issued at 10 p. m. for Lake Superior from Duluth to Houghton, and on the following morning these were extended over the remainder of the upper Lakes, except the west shore of Lake Michigan south of the Escanaba section. At the same time southwest warnings were displayed on the lower Lakes. The warnings were verified over extreme western Lake Superior and on the eastern shore of Lake Michigan, while elsewhere winds of near storm force occurred.

The only small-craft warning issued was that on the morning of the 7th by the Houghton official.

The storm-warning season closed on the 20th, and thereafter only one advisory warning was issued for Lake Michigan—that on the night of the 29th in connection with a disturbance that was advancing from the Plains States.

Cold-wave warnings.—Cold-wave warnings were issued for some portion of the district on eight different dates, but on only one date, namely the 11th, were warnings disseminated over a large portion of the district. On that date cold-wave warnings were issued for portions of the upper Mississippi and lower Missouri Valleys and Middle Plains States, and in the early afternoon the warnings were extended to the eastern and southern limits of the district. The fall in temperature occurred as expected, and on the morning of the 12th the line of zero temperature reached southward into southeastern Iowa.

Cold-wave warnings were also issued on the morning of the 14th for portions of the Plains States and in the afternoon the warnings were extended to include eastern Nebraska, western Iowa, and Missouri. These warnings were not fully verified, but nevertheless a marked fall in temperature occurred throughout the area for which the warnings had been issued.

Cold-wave conditions again developed on the morning of the 16th, when warnings were issued for southern and eastern Montana and for Wyoming, and in the afternoon for central Iowa. On the following morning lower Michigan, Indiana, and southern and eastern Illinois were included. All these warnings were verified, the temperature falling below zero on the morning of the 18th as far south as central Indiana.

A limited cold-wave warning was issued on the morning of the 19th for the extreme upper Missouri Valley, and the warning was verified in part.

The last cold-wave warning for the month was issued on the morning of the 20th and included in its scope upper Michigan and northern lower Michigan. This warning failed of verification owing to the rapid approach of an area of low pressure from the Northwest.

Stock warnings were issued during the month as follows: 6th and 11th, southeastern Wyoming; 13th, Wyoming, western South Dakota, and southern Montana; 14th, Kansas, Missouri, and Nebraska; 16th, Wyoming, Nebraska, and Kansas; 19th, North Dakota.—C. A. Donnel.

NEW ORLEANS FORECAST DISTRICT.

The movement of the areas of high pressure during this month was more eastward than southward and it is due largely to this fact that true cold waves occurred only in the northwestern portion of the district, although cold waves appeared at times to threaten the eastern and southern portions, also. The prevailing character of

pressure distribution was attended also by a comparative absence of stormy weather.

A moderate cold wave occurred on the 12th in the northwestern portion of the district, for which warnings had been issued the previous evening. Warnings were extended over nearly all portions of the remainder of the district on the morning of the 12th, but verifying temperatures did not occur.

Warnings were issued on the morning of the 14th for a cold wave in Oklahoma and the Texas Panhandle and were extended in the afternoon to include Arkansas and the northwestern portion of east Texas; but the cold wave occurred only as indicated in the warning issued in the morning.

On the morning of the 16th, cold-wave warnings were issued for the northern portion of west Texas. The cold wave occurred the following morning as forecast. Cold-wave warnings were extended at night on the 16th to include northwestern Arkansas, Oklahoma, and the northwestern portion of east Texas, and were further extended, on the morning of the 17th, to the coast, except the west coast of Texas. Cold weather extended farther south than in previous cold periods; but the change was gradual and was most felt in the southern portion of the district, on the morning of the 19th, when freezing temperature, or lower, occurred in the interior portions of Texas and Louisiana.

Warnings for stockmen were issued in connection with the cold waves.

Frost warnings for areas in the southern sections of the district were issued on the 15th, 18th, 19th, 20th, 21st, 22d, 27th, 28th, and 31st, and were generally verified.

Small-craft warnings were displayed on the Texas coast on the 12th and were justified. On the 26th Northwest storm warnings were ordered for the east coast of Texas and were verified.

Fire-weather warnings were issued for forested areas in western Oklahoma on the 19th and for areas in western Arkansas and southeastern Texas on the 26th—*R. A. Dyke*.

DENVER FORECAST DISTRICT.

The month was characterized by high temperature, and a deficiency in precipitation, except in the extreme northern portion of the district. North Pacific low-pressure areas were numerous, and a Plateau high-pressure area dominated weather conditions during the latter half of the month.

Warnings for a moderate cold wave were issued for eastern Colorado on the 4th. The southward movement of the HIGH was prevented, however, by another area of low pressure from the north Pacific which spread eastward over southern Wyoming. The temperature fell 10 to 18 degrees in eastern Colorado, but the warnings were verified only in extreme northeastern Colorado, although zero temperatures prevailed in parts of Montana and northeastern Wyoming.

Warnings for a moderate cold wave were issued for north-central Colorado on the 7th. During the following 24 hours the HIGH moved southward into the Plains States, dividing the disturbance, one portion remaining west of the mountains while the other moved rapidly northeastward to the Lake region. The warnings were verified only in the extreme north-central portion of Colorado. By the evening of the 10th pressure was rising along the Canadian border and the temperature ranged from 8 to 16 degrees below zero in the Canadian

Northwest. Warning for a moderate cold wave was issued for eastern Colorado on the evening of the 10th, 36 hours in advance. On the morning of the 11th warnings for a moderate cold wave were issued for Utah, northern Arizona, northern and eastern New Mexico, and for a severe cold wave for eastern Colorado. The warnings for eastern Colorado and northern and eastern New Mexico were repeated on the evening of the 11th. The warnings were verified in eastern Colorado and east of the mountains in New Mexico, but failed on the western slope owing to the appearance of an area of low pressure on the California coast, which subsequently overspread the entire Southwest.

On the morning of the 14th warnings for a moderate cold wave were issued for Utah, northern Arizona, northern and eastern New Mexico, and Colorado. A portion of the LOW remained in the Southwest, however, and the warnings were verified only in the area east of the mountains in New Mexico. Warnings for a moderate cold wave were again issued for eastern Colorado and the district east of the mountains in New Mexico. On the evening of the 16th the warnings were verified in eastern New Mexico and in parts of eastern Colorado, temperatures of zero to 12 degrees above being reported in eastern Colorado. On the evening of the 30th livestock warnings were issued for Utah. Moderately heavy precipitation occurred in northern Utah on the 31st and a temperature of 16 degrees was reported at Modena 36 hours after the issue of the warnings. Frost warnings were issued on several dates for south-central Arizona and were generally fully verified.—*Frederick W. Brist*.

SAN FRANCISCO FORECAST DISTRICT.

Unusually stormy weather prevailed in the San Francisco Forecast District during the month of December, 1922. From the 1st until the 17th, a large high-pressure area extended almost continuously from northeastern Alaska southeastward to the Canadian Northwest. This apparently acted as a barrier to the passage of storms along the northern track and all but one or two entered the United States below the mouth of the Columbia River. As a result the rainfall in California was greater than usual. Beginning about the 19th, a high-pressure area formed over the Central Plateau States and conditions from then until near the end of the month were more nearly normal. Near the end of the month this high-pressure area disappeared and the barometer began rising over northeastern Alaska, which caused the storms from the ocean to again take the southern track.

Storm warnings were issued from one or more places on no less than 17 days. A few were not justified, judging from the velocity of the wind at our coast stations, but ships only a short distance from the coast experienced the full force of these gales. The most severe storm occurred near the end of the month at which time maximum velocities of 68 miles at Tatoosh Island, 76 at North Head and 49 at Eureka were reported.

Besides the storm warnings, frost was predicted at one or more places in California on 15 days. Cold-wave warnings were issued for southern Idaho and eastern Oregon on the 11th. The cold wave came as predicted and most of the frosts likewise occurred. The frosts, however, were not severe enough to do any material damage in the citrus orchards, though they brought the season to a close so far as grapes, tomatoes, etc., were concerned.—*E. A. Beals*.